SINGLE-O-SHELTER HUNA (*Cherax albertisi*) AND REDCLAW (*C. quadricarinatus*) CULTURE

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ABSTRACT

Many hatcheries successfully produced and sold cherax as ornamental crayfish. The attempt to culture cherax in earthen pond to produce consumable size *yabbies* facing the fact that cherax is a good hole digger and usually escapes through the hole in dyke. Single-o-shelter meant to provide shelter for every single spawner as well as hideout for the juvenile produced. The shelter for spawner was a 25 inches long and 2.0 inches diameter PVC pipe randomly spread on pond bottom. Aquatic weed (*Vallisneria torta*) grew in the shallow part of pond to provide hiding place for juvenile. The species stocked is huna and redclaw, each at density of 2 and 6 sets of spawner. One set of spawner consists of 3 males and 5 females weighing averagely around 20 g each. The experimental units are randomly selected to facilitate random block design in 2 rearing period as replicate. The pond dimension is 10x10 m, divide into 3 compartments i.e. feeding, ground, nursery ground and harvest ditch. Water depth at nursery ground was 30 cm and at the other compartments at 60 cm. Follow gravity force, the water in ponds flows at 50—100 L minute^{-1}. Self-made diet distributed into pond twice a day to meet 3% daily feeding ration. Survival rate and specific growth rate of spawner as well as juvenile produced and number of gravid female checked at the end of each rearing period or every 3 months. After 6 months, average weight of redclaw and huna reaching 146.12 ± 34.47 g and 103.7 ± 29.83 g, respectively. Redclaw produced progeny of 5 size groups and huna produced only 2 groups. Respective to the species, average weight of the first offspring batch was 39.03 ± 5.33 and 26.83 ± 2.09 g. Redclaw at 2 sets of spawner and male grow faster than of 6 sets of spawner and female. No survival rate significant difference among ponds indicates that single–o-shelter technique provides sufficient shelter for spawner to grow and reproduce. Male monosex redclaw culture in earthen pond seems to be more promising than mixed-sex and female monosex culture for consumable size production of either huna or redclaw.

KEYWORDS: single-o-shelter, cherax

INTRODUCTION

Cherax sp. is in a current trend in Indonesia as a demanded freshwater ornamental shrimp. Redclaw (*Cherax quadricarinatus*) and crawfish (*Procambarus clarkii*) were yet imported from Australia and United States to meet domestic market demand. In fact, Indonesia indigenous cherax consist of at least 12 species, among others are *Cherax monticola, C. clorentzi*, *C. lakembutu* and *C. albertisi* (Sukmajaya & Suharjo, 2003) which are very potential to culture for elevating fish protein consumption. Cherax seed has been successfully produced in hatcheries (Henryon & Purvis, 2000; Jerry, 2001) and many cherax hatcheries are currently operating in West and Central Java (Wiyanto & Hartono, 2003).

Hatchery-bred cherax grow-out in earthen pond is very common in Australia (Mitchel & Collins, 1989; Jones & Ruscoe, 2000; Jones & Lawrence, 2001) and in concrete pond or aquarium in Indonesia. Cherax grow-out in earthen pond is developing in Indonesia but still facing the anxiety of the possibility of cherax escapes to be paddy pest and in its turn might threaten food security. Just recently,

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Ahmad *et al*. (2006) proven that either huna or redclaw is not a paddy eater. Cannibalism, after ecdysis, is a serious problem faced by the farmers who grow cherax in concrete tank and aquarium (Barki & Karplus, 2000). The use of shelter in cherax grow-out is effective to reduce cannibalism rate but still influencing biological performance such as growth rate.

Single-o-shelter technique is suspected not only would prevent cannibalism to occur but also provide a special territory for every individual; disturbance from other individual is eliminated. In addition, natural shelter set by aquatic plant provides shelter and source of detritus for juvenile feed. Limitation on motoric activities due to conflict in space use between single-o-shelter and natural shelter is expected to create synergism and maximize the conversion of feed energy into cherax meat, in other words, to fasten the growth rate.

Based on market price which approximately reaching Rp 150,000 kg^{-1}, cherax grow-out is more profitable than giant prawn grow-out, even though the price of cherax seed is much more expensive, Rp 3,000-5,000 pcs^{-1}. However, cherax grow-out to produce either juvenile for ornament or adult cherax for spawner is still facing the problem of high cannibalism rate especially in concrete tank and aquarium. The research aims at identifying suitable species cultured in a special earthen pond design easily adopted by farmers. The successful cherax grow-out in such earthen pond is expected to enrich the developing freshwater aquaculture commercial venture.

MATERIALS AND METHODS

The experiment covers field activities to resolve suitable cherax species at different spawner stocking density as well as laboratory activities to analyze water quality and samples. Field activities consist of 2 rearing seasons which is commenced with pond preparation and followed by spawner propagation and ended by juvenile harvest and spawner handling. All activities are executed at aquaculture environment and toxicology laboratory, Research Institute for Freshwater Aquaculture.

The experimental units were 10x10 m^2 ponds prepared with shelter area, which covers 30% of total pond area and planted with various aquatic plants (*Blyxa japonica, Crosulla helmensis, Rotalla macandra*, and *Vallisneria torta*). Three seedlings of each plant were planted at 40 cm interval to cover whole shelter area (Ahmad *et al*., 2006). Pond bottom was divided into 3 zones, i.e. spawning ground, nursery ground, and harvest culvert. PVC pipes, 20 cm long and 5 cm diameter, were set in each zone in such a way that each pair forms T and V shape. Number of PVC pipes set is equal to the number of cherax highest stocking density to accommodate single-O-shelter technique. Water depth was maintained at 40 cm in nursery ground and at 60 cm in spawning ground and harvest culvert using an L-standing PVC outlet pipe. Water was supplied at 50-00 L $minute^{-1}$ from an inlet pipe hung across the pond. Dyke was covered with plastic sheet to prevent cherax from crawling away or digging hole. Pond bottom and dyke were limed at 10 kg $CaCO_3$ $pond^{-1}$.

The tested cherax was Papua huna (*Cherax albertisi*) and Australia redclaw (*Cherax quadricarinatus*) reared in Bogor. Stocking density of each species was 2 and 6 sets of spawner per pond; each set of spawner consists of 5 females and 3 males. Average weight of *C. albertisi* spawner was 19.85 ± 2.55 g and of *C. quadricarinatus* was 25.4 ± 3.46 g. The experimental units were randomly arranged to accomodate 4 treatments, i.e. 2 species and 2 stocking densities. Number of spawner and juvenile produced in each pond was counted on the 3rd and 6th month.

Feeds, homemade pelleted feed, beans (Lawrence *et al*., 2000), and minced sweet potato were broadcasted into each pond every morning and dusk to meet 3%—10% feeding ration per day. The juvenile produced is expected to consume aquatic weed detritus (Garces & Avault, 1985) and uneaten spawner feed. Dissolved oxygen was checked every day at 7.00 AM and for 24 hours at 4 hours interval in the beginning and end of the experiment. The 24-hour DO fluctuation data was plotted in a graph used for critical DO forecast just before dawn. Other water quality variables such as pH, TAN, calcium concentration were monitored every other week.

The biological performance variable confirmed was population growth in term of daily growth rate of spawner and the amount of yield consisted of spawners and juvenile. Survival rate of spawner was estimated from shelter occupancy and the number of the progeny was calculated from the sample obtained by lift net. The experiment was carried out for 6 months which is separated into 2 rearing period of 3 month each. The different on growth among species and stocking densities were tested using standard deviation on final weight at 95% confidence interval.

RESULTS AND DISCUSSION

Aquatic plants which were planted a week after pond inundation grew normally in the first 2 weeks, but then the plants were not able to compete the rapidly growing filamentous alga. The plants, except *V. torta*, start to die in the 3rd week after being planted. In the meanwhile, filamentous alga and water hyacinth (*Eichornia* sp.) grew very rapidly and dominated pond bottom especially in nursery ground. *V. torta* grew normally under the shed of water hyacinth and filamentous alga. Cherax molt was commonly found among *V. torta* cluster or shelter pipes. To prevent further domination of filamentous algae, the alga was scoped every morning and evening.

Dissolved oxygen daily fluctuation at the beginning of the experiment revealed in Figure 1. The difference between DO maximum and DO minimum concentrations was obviously noticeable due to dense filamentous algae and aquatic plants growth even though population of plankton hard to grow as indicated by very high water transparency in each pond. The highest concentration, 23.6 mg L^{-1}, aroused at 13.00 o'clock and the lowest, 4.0 mg L^{-1}, occurred at 07.00.

Dense filamentous algae and aquatic plant growth combined with unpredictable weather lead to high fluctuation of daily dissolved oxygen concentration, especially in the morning (Figure 2). The growth of water hyacinth, *V. torta* and filamentous algae in the pond stocked with *C. albertisi* at lower density was so fast and lead to observable day-to-day reduction of morning dissolved oxygen. Stable water flow and slow growth of water hyacinth population in the pond stocked with either redclaw or huna at higher density keep dissolved oxygen stay at higher concentration.

Wild water hyacinth in the pond stocked with 6 sets of huna spawner (CA61) did not grow as dense as in the other ponds and consequently the dissolved oxygen fluctuated in a higher concentration. In the pond stocked with 6 sets of redclaw spawner (CQ61), wild water hyacinth and planted *V. torta* grew heavily in the first week after inundation and lead to drastic reduction in dissolved oxygen concentration after the 10th day.

The other water quality variables measured biweekly were not showing any distinct differences among ponds. TAN was lower in the pond stocked with lower set of spawner and inhabited heavily by wild water hyacinth (Table 1). Hardness was high due to the addition of lime onto pond bottom to reduce soil acidity and provide cherax with adequate calcium for ecdysis.

Aquatic plants removal from ponds did not distinctly affect DO fluctuation (Figure 3). The highest DO concentration, 10 mg/L, in 18 days measurement during dry season, was found in the stocked with 6 sets of *C. albertisi* and the lowest, 1.6 mg L^{-1}, was in the pond stocked

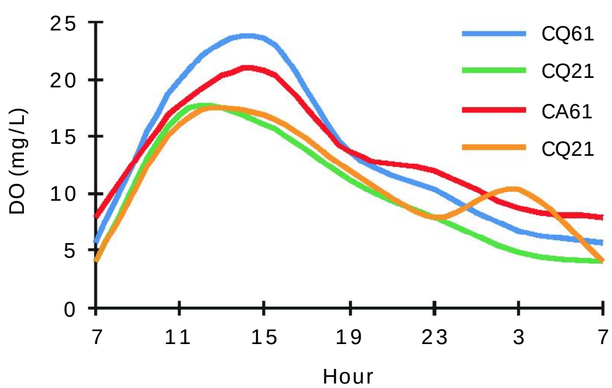

Figure 1. Initial DO daily fluctuation in the ponds stocked with cherax at different density

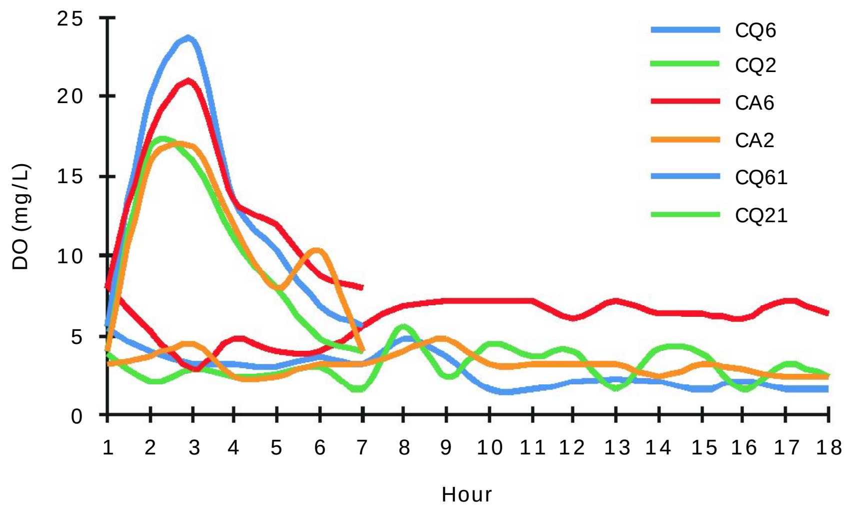

Figure 2. Day-to-day morning dissolved oxygen concentration in the experiment ponds measured for 18 days at 7 PM

Table 1. Initial alkalinity, hardness, TAN and temperature of redclaw and huna experiment pond water

Pond	Temperature (°C)	Hardness (mg L^{-1} $CaCO_3$)	Alkalinity (mg L^{-1} $CaCO_3$)	TAN (mg L^{-1})
C. albertisi 6	25.3–32.3	79.56	88.10–103.66	0.019
C. albertisi 2	24.3–32.3	92.82	82.00–103.82	0.019
C. quadricarinatus 6	25.3–32.3	83.98	83.80–96.60	0.016
C. quadricarinatus 2	25.2–31.3	79.56	76.60–97.59	0.021

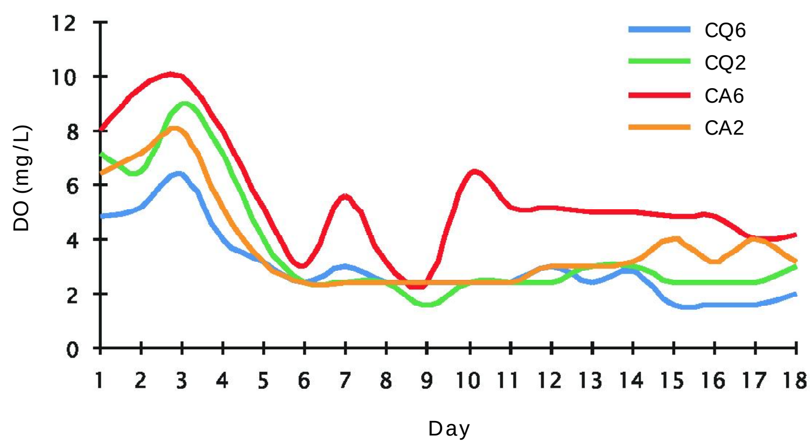

Figure 3. Daily morning dissolved oxygen concentration in the experiment ponds measured for 18 days at 7 PM after aquatic plants removal

with 6 sets of *C. quadricarinatus*. Number of cherax stocked into ponds was obviously not affecting DO concentration. Aquatic plant removal leads to maximum DO concentration increase but not affect the lowest concentration. Filamentous algae grew densely in all ponds seems to steadily keep daily DO concentration fluctuating, even though in the range of optimum concentration for cherax. Daily removal filamentous algae relieve DO extreme fluctuation and penetration of sun light into pond bottom to allow submerges aquatic plant to grow. Decomposed algae and aquatic plant provides natural food for cherax juvenile.

Most of the female in all ponds found to spawn in the first 3-month, at average weight 86.05 ± 30.20 g for redclaw and 64.90 ± 22.70 g for huna. The heaviest redclaw sampled, 150.7 g, and huna, 126.3 g, were not included in the calculation. All females showed the sign of reproduction 3 month after being stocked into each pond. The females with empty brood chamber in the first 3 months were suspected in spent stage or not experiencing the first spawn (Table 2). Due to its small size and the dense growth of filamentous algae and *V. torta*, the juvenile produced in each pond was hardly found.

The hatched juvenile seems to grow fast and reach maximum individual weight of 46.6 g for redclaw and 29.9 g for huna in 3 months. In the same period, the next batch of eggs hatched and the subsequent juvenile produced in at least 5 size groups based on 10 g interval (Figure 4). The capability of huna to reproduce seems not as good as redclaw; it produces only 2-3 size groups at smaller sizes. Average individual weight of the first batch of redclaw juvenile was 39.03 ± 5.33 g and of huna was only 26.83 ± 2.09 g. Average individual weight of redclaw spawner, 146.12 ± 34.47 g, was also heavier than of huna, 103.7 ± 29.83 g, even though the difference was not significant at $P>0.05$. Stocking density affect the growth of redclaw but not huna juvenile.

Table 2. Reproduction cycle composition (%) of redclaw and huna reared in earthen ponds after 3 and 6 months

Pond	3 months					6 months				
	Male	**YB**	**RB**	**Hatch**	**Spent**	**Male**	**YB**	**RB**	**Hatch**	**Spent**
CA 6	27	9	9	9	46	46	18	9	9	18
CA 2	50	0	0	17	33	33	0	0	0	67
CQ 6	22	8	16	16	38	50	7	14	7	22
CQ 2	25	0	25	13	37	34	11	22	11	22

Notes: Color of egg: YB = yellowish brown; RD = reddish brown

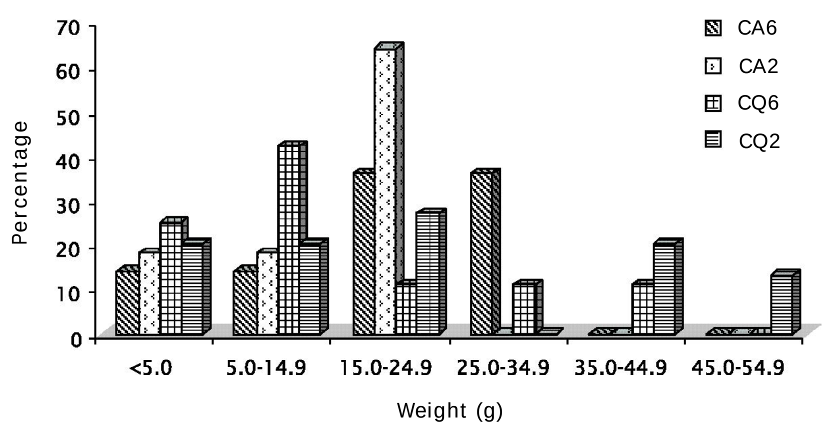

Figure 4. Offspring's individual weight composition of huna and redclaw reared in earthen pond for 6 months.

Average individual weight of the first batch redclaw juvenile produced by 2 sets of spawner was 42.54 ± 3.77 g and heavier ($P<0.05$) than by 6 sets of spawner which only 34.65 ± 3.29 g.

Redclaw achieved maximum weight 185 g that much heavier than maximum weight achieved by huna, 176 g. (Figure 5). Stocking density noticeably affect maximum weight of huna which at density of 6 sets per pond achieved maximum weight only below 120 g, while at 2 sets about 30% of the spawner reached maximum density above 160 g. Most of redclaw attained maximum weight more than 160 g at either 2 or 6 sets stocking density.

Redclaw obviously grows faster (Figure 6) and produces offspring more frequently than does huna. However, daily instantaneous growth of both species is not much different, 0.98% day^{-1} for redclaw and 0.92% day^{-1} for huna. The other advantages compared to huna, redclaw is more colorful and more tolerance to environmental disturbance. For commercial purposes, culturing redclaw seems to be more promising than rearing huna.

Ahmad *et al*. (2005) reported daily growth rate of redclaw and huna ranged 0.75%—1.74%, lower than the growth rate of 1.23%—1.58% reported by Jones & Ruscoe (2000) for small size redclaw. Initial size and age seems to affect growth rate, therefore daily growth rate of redclaw and huna in this experiment was lower than of small size redclaw. Jones & Ruscoe (2000) described that in grow-out pond at stocking density 15 m^{-2}, larger size redclaw grows only 0.63%—0.88% day^{-1}.

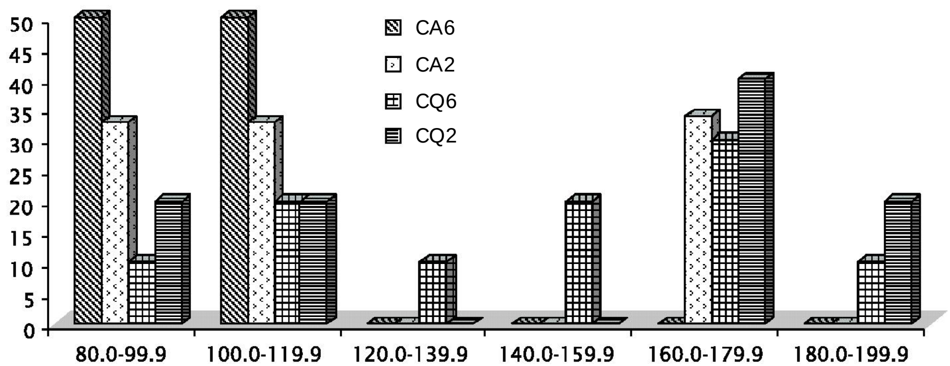

Figure 5. Individual weight distribution of huna and redclaw spawners reared in earthen pond for 6 months

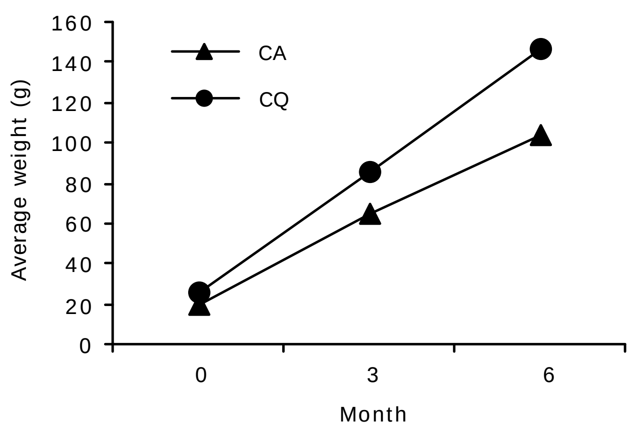

Figure 6. The growth of redclaw and huna spawners reared in earthen pond for 6 months

The decline on growth rate with increasing size and stocking density is attributable to behavioral factors (Jones & Ruscoe, 2000) and natural food availability (Allan & Maguire, 1992). At high density and large size, interaction and antagonism among individual tend to increase and possibly escalating organic waste deteriorate pond bottom sediment (Chien & Lai, 1988). The average weight of first progeny originated from 2 sets of spawner that was significantly heavier than from 6 sets of spawner is an obvious proof of size and stocking density effect on growth rate of either redclaw or huna.

Number of size group of cherax has no effect on either growth or survival rate, instead Qin *et al*. (2001) found that specific growth rate of small, medium a large *C. tenuimanus* in mixed group was higher than those in graded group. The finding of Qin *et al*. (2001) clarify the fact that average weight of 90 days old redclaw in mixed group in this experiment is comparable to140 days old redclaw in Jones & Ruscoe (2000) experiment. Size grading to avoid cannibalism seems not a necessity in cherax culture, instead partitioning food resource among different sizes may reduce the degree of competition.

Estimated from 80%—85% shelter occupancy, survival rate of spawners ranged from 80 to 85%. Calculated from sampling result using 1 m^{-2} lift net, number of survived <5 g individual weight progeny in the pond stocked with 2 and 6 redclaw, and 2 and 6 huna are 240 and 160, and 280 and 180, respectively. Lift net is not an effective gear to harvest >5 g cherax, consequently it sampled only the small size and gave a representation that lower spawner density produce more progeny. In fact, most of the progeny occupied aquatic plant zone in where lift net not possible to operate.

Stocking density up to 60 m^{-2} has no effect on reproduction performance and survival of redclaw spawner (Barki & Karplus, 2000). In this experiment, spawner-stocking density was less 0.5 m^{-2}; estimated from 30 female that produce 100 seeds each, within 3 months there will be more than 30 progeny m^{-2}. Many cherax breeders inform that they experienced to witness redclaw spawns 3-4 times a year. Assumedly, within one year a 100 m^{-2} ponds would hold 3,000—9,000 redclaw or huna from stocking density 2—6 sets with sex ratio 3 males to 5 females. The fact, number of progeny calculated based on sampling data was far less than those numbers. Most possibly, predation by several predators such as nymphs, water beetles, and tadpoles conspicuously reduces the number of newly hatched cherax and possible that some of the progeny fled away or the samples do not represent population. Total number of escapees trapped in the net placed at outlet was around 100 for 3 months.

Male redclaw grows faster and reaching larger final size than the female, especially in monosex culture. In this experiment, the largest male weighted 185 g and female 176 g. In monosex culture, male grows 53% faster than female (Lawrence, 2000). Male grows 215%—224% faster and female grows 52%—81% faster in monosex culture compare to in mixed-sex population (Curtis & Jones, 1995; Sagi *et al.*, 1997). Redclaw male monosex culture seems to be more promising than mixed-sex and female monosex culture. Stocking size for sex identification becomes a key factor in executing monosex redclaw culture.

Survival rate of spawners that was not significantly different between stocking densities indicates that single-O-shelter provides sufficient hide out for newly molted spawner protection; no indication of cannibalism and antagonism detected. More progeny size groups produced in 6 sets stocking density indicates that single-O-shelter also provide secure and favorable environment for spawners to reproduce. *V. torta* might provide more than enough shelter and natural food for redclaw juvenile especially which is produced by 2 sets of spawner that grow significantly faster.

After 11 months, the difference in stocking density still not affecting population size but species did. The yield at total harvest after 11 months rearing of *C. albertisi* and *C. quadricarinatus* was 668 and 303 individual, respectively. *C. albertisi* seems to be more productive than *C. quadricarinatus*, but *C. quadricarinatus* produce larger individual than *C. albertisi* (Figure 7). Based on morphological observation, mainly the existence of petasma or male genital organ, both species generate more female than male at ratio 6 to 4 for *C. albertisi* and 2 to 1 for *C. quadricarinatus*.

The potentiality of *C. albertisi* to reproduce in earthen pond seems to be higher than *C. quadricarinatus*.

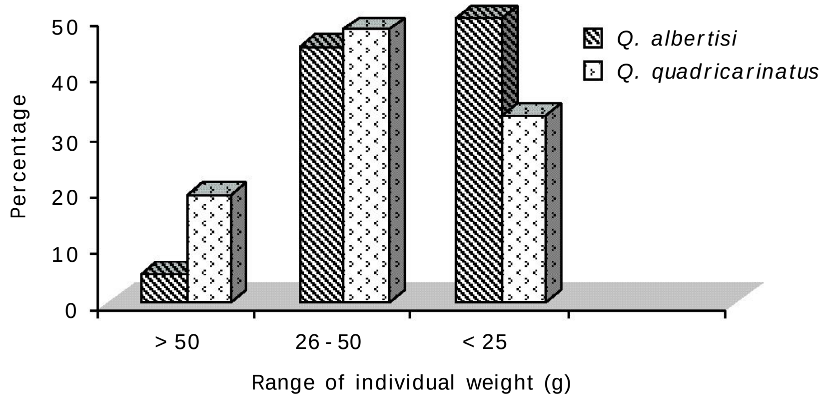

Figure 7. Size composition of *C. albertisi* and *C. quadricarinatus* harvested after 11 month of rearing in earthen pond

CONCLUSION

Single-o-shelter technique with *V. torta* provides sufficient hideout and favorable environment for cherax to grow and reproduce. The capability of cherax to reproduce naturally in earthen pond ensures the application of simple, profitable and easy to adopt cherax culture. Redclaw reproduces more frequently and grows faster than huna. Male redclaw grows faster than the female and more promising to culture for consumable size yabbies production.

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